Unequal Exposure to Ecological Hazards: Environmental Injustices in the Commonwealth of Massachusetts

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This study analyzes the social and geographic distribution of ecological hazards across 368 communities in the Commonwealth of Massachusetts. Combining census data with a variety of environmental data, we tested for and identified both income-based and racially based biases to the geographic distribution of 17 different types of environmentally hazardous sites and industrial facilities. We also developed a composite measure of cumulative exposure to compare the relative overall risks characteristic of each community. To the best of our knowledge, this point system makes this the first environmental justice study to develop a means for measuring and ranking cumulative exposure for communities. The study also controls for the intensity of hazards in each community by accounting for the area across which hazards are distributed. The findings indicate that ecologically hazardous sites and facilities are disproportionately located and concentrated in communities of color and working-class communities. The implication of this research for policymakers and citizen advocates is that cumulative exposure of residents to environmentally hazardous facilities and sites should receive greater consideration regarding community demographics and environmental health indicators. We conclude that the provision of additional resources for environmental monitoring and ranking, as well as yearly progress reports, is necessary for communities and state agencies to achieve equal access to clean and healthy environments for all residents. ***Key words*****: environmental justice, environmental policy, exposure assessment, hazardous waste sites, public health, toxic release inventory.** ***Environ Health Perspect*** **110(suppl 2):277–288 (2002).**
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We analyze whether environmentally hazardous industrial facilities, power plants, municipal solid waste combustors (incinerators), toxic waste sites, landfills of all types, and trash transfer stations are unequally distributed regarding the income and/or racial composition of communities in Massachusetts. We used demographic data from the 1990 U.S. Census, as well as data collected in the spring and summer of 2000 from the Massachusetts Department of Environmental Protection (DEP), U.S. Environmental Protection Agency (U.S. EPA), and the Massachusetts Toxics Use Reduction Institute, to analyze the exposure rates of all 351 cities and towns (minor civil divisions, or MCDs) in the state to the environmentally hazardous industrial facilities and sites listed above. Although 2000 U.S. Census data would have been more appropriate for us to use, it was not available at the time. At least one study shows that biases to the distribution of ecological hazards worsen over time (*1*).

In addition to these 351 cities and towns in Massachusetts, we also included seven subtowns or neighborhoods within the larger town of Barnstable: Barnstable, Centerville, Cotuit, Hyannis, Marstons Mills, Osterville, and West Barnstable. We also include 12 subtowns or neighborhoods within the larger city of Boston: Allston/Brighton, Charlestown, Dorchester, East Boston, Hyde Park, Jamaica Plain, Mattapan, Roslindale, Roxbury, South Boston, West Roxbury, and Downtown Boston (for the purposes of the report, Downtown Boston encompasses Central Boston and Chinatown, Back Bay and Beacon Hill, the South End, and the Fenway/Kenmore neighborhoods). Because these more specific neighborhoods making up all of Boston and Barnstable are included, summary data for all-Boston and all-Barnstable are excluded from the totals. As a result, a total of 368 communities are analyzed in this report. Only in Tables 1 and 2 of this report, where the most overburdened communities in the state are ranked, are Boston and Barnstable as "all neighborhoods combined" reintroduced to create a total of 370 communities.)

Each of the 368 communities is classified by class and racial composition. Median household income determines the class status of a community (1), low income, \$0–\$29,999; (2) medium–low income, \$30,000–\$39,999; (3) medium–high income, \$40,000–\$49,999; and (4) high income, \$50,000 and above. These categories reflect reasonable cutoff points in the data because, first, the data have no distinct gaps in the income distribution of towns, and second, the \$40,000 cutoff point divides the lower- and higher-income communities into roughly equally sized halves (Table 3). The distribution of incomes takes the shape of a relatively normal curve with a mean of \$41,293 and a standard deviation of \$11,742. We selected a \$10,000 decrease/increase from \$40,000 on the basis of generating reasonably sized groups with easily recognizable boundaries. The lower-income groups are not intended to indicate poverty conditions.

The percentage of total population made up of people of color determines the racial composition of a community, which we coded as follows, (1) low minority, less than 5% people of color; (2) moderately low minority, 5–14.99%; (3) moderately high minority, 15–24.99%; and (4) high minority, 25% and greater. The vast majority of towns in Massachusetts have very small minority populations of less than 5%. However, when we analyzed the remaining towns (Table 4), 10% increases in population proportions seemed logical for generating relatively acceptable frequencies in each category. The distribution of non-White populations as percentage of total population is extremely positively skewed, with a mean of 4.5% and a standard deviation of 9.5. Only nine communities in the state have between 15 and 24.99% people of color, and 11 communities have 25% or more.

We made comparisons of low- and high-income communities and of low–minority- and high–minority-status communities in terms of exposure rates to environmentally hazardous industrial facilities, waste sites, power plants, incinerators, trash transfer stations, and landfills of all types. As illustrated in Table 5, we assigned a point total to each facility or site based on our assessment of the relative risks it typically represents to the community. We then added these point totals for each community and divided by total area to arrive at a density figure. The density figure provides a more accurate assessment of the environmental hazards confronting a given community because it

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controls for the size the community and the severity of the facility/site. Among our findings: low-income communities face a cumulative exposure rate to environmentally hazardous facilities and sites that is 3.13–4.04 times greater than that for all other communities (measured by median household income) in the state. In addition, high-minority communities face a cumulative exposure rate to environmentally hazardous facilities and sites that is nearly nine times greater than that for low-minority communities. Clearly, not all communities in Massachusetts are polluted equally—lower-income communities and communities of color are disproportionately impacted.

We define environmental injustice as unequal access to healthy and clean environments, including environmental amenities. We can better understand this broad definition in light of the definition of environmental justice, which we borrow from Bryant (*2*). Although we do not limit our definitions of environmental racism and environmental classism to conditions characterized by an overburden of ecological hazards, we consider such overburdens to be indicators of both environmental racism and environmental classism. We also stress that this study makes no attempt to argue causal

Table 1. Most intensively overburdened communities in Massachusetts (total points per square mile).

Rank	Town name	Points per square mile	Class status of town	Racial status of town
1	Downtown Boston[a]	224.8	Low income ($29,468)	High minority (31.9%)
2	Charlestown	134.3	Medium–low ($35,706)	Moderate–low minority (5.1%)
3	Chelsea	127.4	Low income ($24,144)	High minority (30.3%)
4	South Boston	126.2	Low income ($25,539)	Low minority population (4.2%)
5	East Boston	123.3	Low income ($22,925)	Moderate–high minority (23.6%)
6	Cambridge	115.0	Medium–low income ($33,140)	Moderate–high minority (24.9%)
7	Somerville	104.7	Medium–low income ($32,455)	Moderate–low minority (11.3%)
8	Roxbury	101.3	Low income ($20,518)	High minority (94.0%)
9	Allston/Brighton	100.0	Low income ($25,262)	High minority (26.9%)
10	Watertown	98.6	Medium–high income ($43,490)	Low minority (3.8%)
11	Everett	98.1	Medium–low income ($30,786)	Moderate–low minority (6.0%)
12	Boston (all neighborhoods)	84.0	Low income ($29,180)	High minority (37%)
13	Dorchester	81.3	Low income ($29,468)	High minority (50.7%)
14	Lawrence	59.3	Low income ($22,183)	High minority (34.9%)
15	Malden	57.8	Medium–low income ($34,244)	Moderate–low minority (10.1%)
Totals	15 towns		14 of the 15 most intensively overburdened towns are of lower-income status (less than $40,000)	9 of the 15 most intensively overburdened towns are of higher minority status (15% or more people of color)

[a]Downtown Boston encompasses Central Boston and Chinatown, Back Bay and Beacon Hill, the South End, and the Fenway/Kenmore neighborhoods.

Table 2. Most extensively overburdened communities in massachusetts (total points per town).

Rank	Town	Total points	Points per square mile	Class status of town	Racial status of town
1	Boston (all)	3,972	84	Low income ($29,180)	High minority (37%)
2	Worcester	1,248	32.4	Low income ($28,955)	Moderate–low minority (12.7%)
3	Downtown Boston[a]	1,014	224.8	Low income ($29,468)	High minority (31.9%)
4	Springfield	999	30.1	Low income ($25,656)	High minority (31.2%)
5	Cambridge	820	115.0	Medium–low income ($33,140)	Moderate–high minority (24.9%)
6	New Bedford	619	25.8	Low income ($22,647)	Moderate–low minority (12.2%)
7	Waltham	611	44.9	Medium–low income ($38,514)	Moderate–low minority (8.7%)
8	Lowell	611	42.0	Low income ($29,351)	Moderate–high minority (18.8%)
9	East Boston	556	123.3	Low income ($22,925)	Moderate–high minority (23.6%)
10	Framingham	537	20.3	Medium–high income ($42,948)	Moderate–low minority (9.6%)
11	Brockton	502	23.2	Medium–low income ($31,712)	Moderate–high minority (19.6%)
12	Dorchester	490	81.3	Low income ($29,468)	High minority (50.7%)
13	Pittsfield	490	11.6	Low income ($29,987)	Low minority (4.6%)
14	Lynn	488	36.2	Low income ($28,553)	Mod.–high minority (17.0%)
15	Fall River	477	12.5	Low income ($22,452)	Low minority (2.7%)
16	Newton	467	25.6	High income ($59,719)	Moderate–low minority (7.0%)
17	Woburn	461	35.7	Medium–high income ($42,679)	Low minority (3.0%)
18	Chicopee	451	18.9	Low income ($28,905)	Low minority (4.4%)
19	Natick	443	27.6	Medium–high income ($49,229)	Low minority (4.7%)
20	Somerville	442	104.7	Medium–low income ($32,455)	Moderate–low minority (11.3%)
Total				16 of 20 towns most extensively overburdened towns are lower income status ($39,999 or less)	9 of 20 towns most extensively overburdened are of higher minority status (15% or more)

[a]For the purposes of this report, downtown Boston encompasses Central Boston and Chinatown, Back Bay and Beacon Hill, the South End, and the Fenway/Kenmore neighborhoods. Cumulative data on the median household income is not available, but appears to fall below the $29,179 figure for Greater Boston as a whole (a low-income category).

Table 3. Median household income.

Income bracket	Frequency	%	Valid %	Cumulative %
$0 to $29,999	50	13.6	13.6	13.6
$30,000 to $39,999	137	37.2	37.2	50.8
$40,000 to $49,999	114	31.0	31.0	81.8
$50,000 or more	67	18.2	18.2	100.0
Total	368	100.0	100.0	

Table 4. Percentage of population that is non-White.

Income bracket	Frequency	%	Valid %	Cumulative %
Less than 5%	299	81.3	81.3	81.3
5–14.99%	49	13.3	13.3	94.6
15–24.99%	9	2.4	2.4	97.0
25% or more	11	3.0	3.0	100.0
Total	368	100.0	100.0	

associations between social and environmental conditions. It is descriptive in its orientation alone, and neither the data nor the type of analysis allows for discussions of causality.

Unequal Exposure to Hazardous Waste Sites

In thousands of communities across the United States, billions of pounds of highly toxic chemicals, including mercury, dioxin, polychlorinated biphenyls, arsenic, lead, and heavy metals such as chromium, have been dumped in the midst of unsuspecting neighborhoods. These sites poison the land, contaminate drinking water, and potentially cause cancer, birth defects, nerve and liver damage, and other illnesses. In a 1991 study, the National Research Council found that over 41 million people lived within 4 miles of at least one of the nation's roughly 1,500 Superfund waste sites (*3*). Although these dumps are the worst of the worst, in 1993 the U.S. Office of Technology Assessment estimated that the United States has as many as 439,000 other hazardous waste sites (*4*).

In Massachusetts, 32 sites, located (totally or partially) in 42 towns, are on the U.S. EPA NPL, or Superfund, list. The Fort Devens site encompasses parts of the towns of Ayer, Shirley, Lancaster, and Harvard. The Ford Devens–Sudbury Training Annex site encompasses parts of the towns of Sudbury, Maynard, Hudson, and Stow. The Hanscom Field/Hanscom Air Force Base site encompasses parts of Bedford, Concord, Lexington, and Lincoln. The Otis Air National Guard/Camp Edwards site encompasses parts of Falmouth, Bourne, Sandwich, and Mashpee. The South Weymouth Naval Air Station site encompasses parts of Weymouth, Abington, and Rockland. The W.R. Grace & Company, Inc., site encompasses parts of Acton and Concord. The remaining 26 sites are located in single towns (*5*). These towns are home to more than 1,072,017 residents, including 70,491 people of color. Approximately 61,000 people live within a 3-mile radius of the Iron Horse Park Superfund site in North Billerica. In addition to these Superfund sites, Massachusetts has over 21,000 DEP hazardous waste sites. Together, 3,389 of these Superfund or DEP sites are considered to present health risks.

Table 5. Environmental hazard point system.

Type of hazardous facility or site	Points for rating severity of each facility or site
DEP hazardous waste site (general)	1
DEP hazardous waste site (Tier I–II)	5
U.S. EPA NPL (Superfund) waste site	25
Large power plant—top five polluter	25
Small power plant	10
Proposed power plant	5
TURA industrial facility	5
Municipal incinerator	20
Resource recovery facility	10
Incinerator ash landfill	5
Demolition landfill	3
Illegal site	5
Sludge landfill	5
Tire pile	5
Municipal solid waste landfill	5
Trash transfer station	5

For residents living near Superfund and other major toxic waste sites, the National Research Council also found a disturbing pattern of elevated health problems, including heart disease, spontaneous abortions and genital malformations, and death rates; infants and children suffer a higher incidence of cardiac abnormalities, leukemia, kidney–urinary tract infections, seizures, learning disabilities, hyperactivity, skin disorders, reduced weight, central nervous system damage, and Hodgkin's disease (*6–8*). Scientists also believe that exposure to industrial chemicals contributed to the dramatic increases since the 1950s in cancer of the testis, prostate gland, kidney, breast, skin, and lung, as well as malignant myeloma, non-Hodgkin's lymphoma, and numerous childhood cancers (*9–11*)—attributable to the death of half a million Americans each year. In Massachusetts, elevated rates of leukemia (especially among children) have been linked to the industrial chemical trichloroethylene found in the town of Woburn's drinking water, as well as tetrachloroethylene in drinking water on the Upper Cape (*12–14*). Massachusetts now has one of the highest rates of breast cancer in the country—some 4,400 women are diagnosed and 1,000 women die each year. Women living on Cape Cod are particularly vulnerable, with a 20% higher rate of breast cancer than women living elsewhere in the state (*15*).

Many current policy initiatives may be intensifying problems they were designed to cure. Most environmental laws require businesses to contain pollution sources for more proper treatment and disposal (in contrast to the previous practice of dumping on-site or into nearby commons). Once the pollution is "trapped," the manufacturing industry pays the state or a private company for its treatment and disposal. The waste, now commodified, becomes mobile, crossing local, state, and even national borders in search of "efficient" (i.e., low-cost and politically feasible) areas for treatment, incineration, and/or disposal. More often than not, the waste sites and facilities are themselves hazardous and located in poor or working-class neighborhoods and communities of color (*16–18*). In this respect, an environmental issue affecting the general population has been addressed in a manner that displaces the problem in a new form onto more politically marginalized sectors of the population (*19*).

Hazardous waste sites nationwide are among the more concentrated environmental hazards confronting low-income neighborhoods and communities of color. According to a 1987 report by the United Church of Christ's Commission on Racial Justice (*20*), three of every five African Americans and Latinos nationwide live in communities that have illegal or abandoned toxic dumps. Communities with one hazardous waste facility have twice the percentage of people of color as those with none, and the percentage triples in communities with two or more waste sites. A subsequent follow-up study conducted in 1994 has now found the risks for people of color to be even greater than in 1987: they are 47% more likely than Whites to live near these potentially health-threatening facilities (*21*). In short, race and poverty are the two most critical demographic factors for determining where commercial hazardous waste facilities are located in the United States (including hazardous waste generators of all sizes across Massachusetts) (*22*). Industry itself often blatantly states that the "disempowered" of American society should serve as the dumping ground for American business. A 1984 report by Cerrell Associates for the California Waste Management Board, for instance, openly recommended that polluting industries and the state locate hazardous waste facilities in "lower socio-economic neighborhoods" because those communities had a much lower likelihood of offering political opposition (*23*).

Federal governmental enforcement actions also appear to be uneven regarding the class and racial composition of the impacted community. According to a 1992 nationwide study, Superfund toxic waste sites in communities of color are likely to be cleaned 12–42% later than are sites in White communities. Communities of color also witness average government penalties for violations of hazardous waste laws ($55,318) that are only one sixth the average penalty assessed in predominantly White communities ($335,566). The study also concluded that the government takes an average of 20% longer to place toxic waste dumps in minority communities on the NPL, or Superfund, list for cleanup than it does in placing sites located in White areas (*24*).

Massachusetts currently has over 21,038 hazardous waste sites, including 3,389 more serious Tier I–II sites, according to March 2000 DEP data (*25*). As required under state law, hazardous waste sites must be ranked according to the severity of their risk to human health and the environment. The DEP has developed a tier classification system for determining the danger level of a hazardous waste site to the public health and the environment. Sites can be classified as Tier IA, IB, IC, or II, with Tier IA sites requiring the most stringent oversight and Tier II the least. We used a numerical ranking sheet (NRS) to calculate the numerous ecological and public health factors that determine a site's classification. The NRS has five main sections (*25*):

1. The *exposure pathways* section evaluates the ways a person can be exposed to toxics, specifically the soil, groundwater, surface water, and air.
2. The *disposal site characteristics* section evaluates the toxicity of the released material(s).
3. The *human population and land uses* section evaluates the potential risks based on nearby population and land and water uses.
4. The *ecological population* section evaluates the potential risks posed to the environment based on the site's proximity to sensitive areas such as wetlands and endangered species.
5. The *mitigating disposal site specific conditions* section takes into account conditions at the site not otherwise factored into the NRS.

DEP ranks a large number of the most serious Tier IA sites in suburban areas rather than in urban areas such as Boston, citing drinking water issues as one of the primary reasons. The presence of a hazardous waste site in a larger urban area where the drinking water is transported from a distant reservoir may not pose the same threat as it would in a suburban/rural community dependent on local groundwater sources.

As indicated in Table 6, a significant concentration of both Tier I–II and nontier sites appear to be concentrated in lower-income communities in Massachusetts. Communities where median household income is less than $30,000 contain an average of 120.9 DEP hazardous waste sites, whereas communities where the median household income is $30,000 or greater contain an average of 41.9–50.2 hazardous waste sites. As a result, low-income communities average roughly 2–3 times more DEP hazardous waste sites than higher-income communities.

However, if lower-income communities are typically larger in size, one would expect them to have a higher number of such sites. To control for the size of the community, we calculated the number of sites per square mile to obtain a more accurate exposure rate. This revealed an even more pronounced class bias. Low-income communities, where median household income is less than $30,000, average nearly 14 DEP hazardous waste sites per square mile. In contrast, higher-income communities, where median household income is $30,000 or more, average 3.1–4.1 hazardous waste sites per square mile. Thus, low-income communities have approximately 3.5–4 more hazardous waste sites per square mile than higher-income communities. These figures remain relatively consistent with comparisons of the more serious Tier I–II hazardous waste sites. In short, low-income communities in Massachusetts experience a far higher exposure rate to DEP hazardous waste sites than higher-income communities.

These disparities repeat for communities of color. In Massachusetts, communities where people of color compose less than 5% of the population average 41.2 DEP hazardous waste sites, whereas communities where people of color compose 25% or more of the population average 162.5 sites. Communities considered moderately high minority (where people of color compose 15–24.99% of the population) average nearly 190 sites. As a result, higher-minority communities, where people of color compose 15% or more of the population, average well over 4 times as many DEP hazardous waste sites as low-minority communities.

To control for the size of the community, we calculated the number of sites per square mile to obtain a more accurate exposure rate. This revealed an even more pronounced racial bias. High-minority communities average 27.2 DEP hazardous waste sites per square mile, whereas low-minority communities average 2.9 hazardous waste sites per square mile. Thus, high-minority communities have 9 times more hazardous waste sites per square mile than low-minority communities. These figures remain consistent with comparisons of the more serious Tier I–II hazardous waste sites. In short, communities of color experience a far higher exposure rate to DEP hazardous waste sites than predominantly White communities, indicating that race is strongly associated with the location of tier and nontier hazardous waste sites in Massachusetts (Table 7).

Only in the case of U.S. EPA Superfund sites do the class and racial biases associated with DEP hazardous waste sites disappear. This trend could be accounted for by the high number of Superfund sites on military facilities often located in rural and suburban locales near more affluent communities, particularly on Cape Cod. At least 47 Tier IA sites are in Bourne because of contamination from the Massachusetts Military Reservation (Figure 1).

Table 6. Class-based disparities in the location of hazardous waste sites.

Median household income (1990 U.S. Census category)	Number of towns (% of all towns)	DEP hazardous waste sites			DEP tier I–II hazadous waste sites			Towns with U.S. EPA Superfund sites			Average number of DEP hazardous waste sites per town	Average number of DEP hazardous waste sites per square mile
		Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean		
$0 to $29,999 (low)	50 (13.6)	6,044	(28.7)	120.9	987	(29.1)	19.7	5	(10.4)	0.10	120.9	13.9
$30,000 to $39,999 (medium–low)	137 (37.2)	6,863	(32.6)	50.1	1,101	(32.5)	8.0	14	(29.2)	0.10	50.1	4.1
$40,000 to $49,999 (medium–high)	114 (31.0)	4,771	(22.7)	41.9	742	(21.9)	6.5	17	(35.4)	0.15	41.9	3.1
$50,000 or more (high)	67 (18.2)	3,360	(16.0)	50.2	559	(16.5)	8.3	12	(25.0)	0.18	50.2	3.2
Totals	368 (100)	21,038	(100)		3,389	(100)		48	(100)		63.3	5.0

Information on all hazardous waste sites was provided by DEP and U.S. EPA databases in March 2000. All DEP waste site information provided above includes U.S. EPA Superfund sites as part of the count.

Table 7. Racially-based disparities in the location of hazardous waste sites.

Non-White population (1990 U.S. Census category)	Number of towns (% of all towns)	DEP hazardous waste sites			DEP tier I–II hazadous waste sites			Towns with U.S. EPA Superfund sites			Average number of DEP hazardous waste sites per town	Average number of DEP hazardous waste sites per square mile
		Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean		
5–14.99% (low–moderate)	49 (13.3)	5,219	(24.8)	106.5	849	(25.1)	17.3	16	(33.3)	0.33	106.5	9.0
15–24.99% (moderate–high)	9 (2.4)	1,708	(8.1)	189.8	257	(7.6)	28.6	3	(6.3)	0.33	189.8	23.4
25% or more (high)	11 (3.0)	1,787	(8.5)	162.5	314	(9.3)	28.6	0	(0.0)	0.00	162.5	27.2
Totals	368 (100)	21,038	(100)		3,389	(100)		48	(100)		63.0	

Information on all hazardous waste sites was provided by DEP and U.S. EPA databases in March 2000. All DEP waste site information provided above includes U.S. EPA Superfund sites as part of the count.

Unequal Exposure to Landfills and Transfer Stations

Landfills can also pose hazards to communities. Seven former Massachusetts landfills are now federal Superfund sites. Even newer landfills, which are lined with plastic, can threaten underground water supplies. Tables 8 and 9 provide data on seven different types of landfills and related facilities: incinerator ash landfills, demolition landfills, illegal sites, sludge landfills, tire piles, municipal solid waste landfills (garbage dumps), and trash transfer stations. Of these sites, incinerator ash landfills are typically most hazardous, because fly ash wastes produced by incinerators and power plants contain concentrated levels of heavy metals such as arsenic, lead, and cadmium; radioactive elements; cancer-causing organic compounds; and other contaminants.

Massachusetts has a total of 954 different landfill types, of which the majority (566) are garbage dumps. As outlined in the Tables 8 and 9, the state's landfills and trash transfer stations are concentrated in lower-income communities and communities of color. In communities where the median household income is less than \$30,000, there are 0.18 of these landfill-types per square mile, a figure slightly higher than the 0.13–0.15 rates for higher-income communities. Municipal solid waste landfills make up 57.5% of all landfill types and are found in 91.3% of all communities, making them relatively constant across all communities. When municipal solid waste landfills are removed from the analysis, it is clear that lower-income communities (<\$40,000 average income) have a much greater proportion of every other type of landfill than higher-income communities (≥\$40,000 or above). For instance, whereas lower-income communities make up 50.8% of all towns in the state, they are home to 58.9% of all incinerator ash landfills, 66.7% of all demolition landfills, 71.4% of all illegal sites, 74.5% of all sludge landfills, 69.5% of all tire piles, and 58.9% of all transfer stations.

Racially based biases to the distribution of landfill types are prominent. Analyzing all landfill types, communities where people of color compose less than 5% of the population average 0.13 of all landfill types per square mile, whereas communities where people of color compose 25% or more of the population average 0.36 landfill types per square mile, a rate nearly 3 times higher. These data clearly reveal race biases and class biases to the location of all landfill types, with the exception of municipal solid waste landfills.

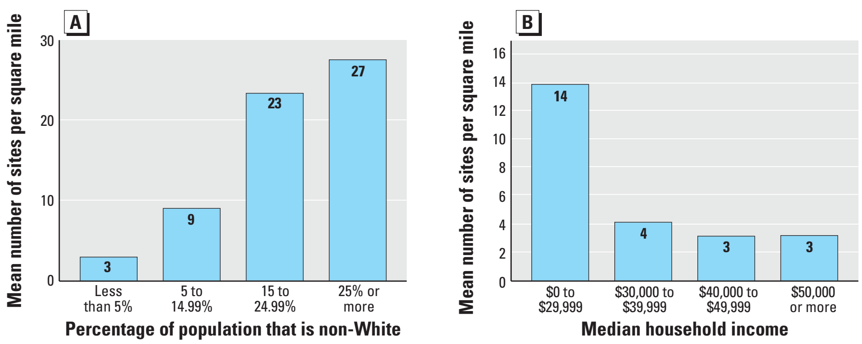

Figure 1. Unequal exposure to hazardous waste sites, compared with an average of 4.94 sites per square mile for all 368 Massachusetts communities in 2000. (*A*) Exposure to hazardous waste sites by race. (*B*) Exposure to hazardous waste sites by class.

Unequal Exposure to Polluting Industrial Facilities

American industry produces enormous quantities of pollution and toxic waste each year. According to the U.S. EPA Toxic Release Inventory (TRI) for 1998, some 23,000 facilities reported a total of 7.3 billion pounds of chemical pollutants released into the nation's air, water, land, and underground areas. The vast majority of these pollutants—93.9% (or 6.9 billion pounds)—were released into the environment directly on-site (*26*). Thus, citizens who work and reside in the communities in

Table 8. Class-based disparities in the location of all landfill types.

Median household income (1990 U.S. Census category)	Number of towns (% of all towns)	Incinerator ash landfills Count (%)	Demolition landfills Count (%)	Illegal sites Count (%)	Sludge landfills Count (%)	Tire piles Count (%)	Municipal solid waste landfills Count (%)	Transfer stations Count (%)	Average number of all landfill types per town	Average number of all landfill types per square mile
\$0 to \$29,999 (low)	50 (13.6)	2 (11.8)	8 (20.5)	7 (33.3)	12 (20.3)	5 (21.7)	69 (12.2)	33 (14.4)	2.9	0.18
\$30,000 to \$39,999 (med.–low)	137 (37.2)	8 (47.1)	18 (46.2)	8 (38.1)	32 (54.2)	11 (47.8)	203 (35.9)	102 (44.5)	2.8	0.13
\$40,000 to \$49,999 (med.–high)	114 (31.0)	7 (41.2)	9 (23.1)	5 (23.8)	12 (20.3)	5 (21.7)	185 (32.7)	62 (27.1)	2.5	0.15
\$50,000 or more (high)	67 (18.2)	0 (0.0)	4 (10.3)	1 (4.1)	3 (5.1)	2 (8.7)	109 (19.3)	32 (14.0)	2.3	0.14
Totals	368 (100)	17 (100)	39 (100)	21 (100)	59 (100)	23 (100)	566 (100)	229 (100)	2.6	0.15

Information on all landfills was provided by DEP databases in April 2000.

Table 9. Racially based disparities in the location of all landfill types.

Non-White population (1990 U.S. Census category)	Number of towns (% of all towns)	Incinerator ash landfills Count (%)	Demolition landfills Count (%)	Illegal sites Count (%)	Sludge landfills Count (%)	Tire piles Count (%)	Municipal solid waste landfills Count (%)	Transfer stations Count (%)	Average number of all landfill types per town	Average number of all landfill types per square mile
Less than 5% (low)	299 (81.3)	11 (64.7)	30 (76.9)	14 (66.7)	50 (84.7)	21 (91.3)	445 (78.6)	180 (78.6)	2.5	0.13
5–14.99% (low–moderate)	49 (13.3)	5 (29.4)	4 (10.3)	3 (14.3)	5 (8.5)	2 (8.7)	92 (16.3)	35 (15.3)	3.0	0.16
15–24.99% (moderate–high)	9 (2.4)	0 (0.0)	3 (7.7)	0 (0.0)	4 (6.8)	0 (0.0)	17 (3.0)	8 (3.5)	3.6	0.30
25% or more (high)	11 (3.0)	1 (5.9)	2 (5.1)	4 (19.0)	0 (0.0)	0 (0.0)	12 (2.1)	6 (2.6)	3.1	0.36
Totals	368 (100)	17 (100)	39 (100)	21 (100)	59 (100)	23 (100)	566 (100)	229 (100)	2.6	0.15

Information on all landfills was provided by DEP databases in April 2000.

which these facilities are located typically experience much greater exposure rates to industrial pollutants (*27*).

Exposure to industrial pollution—especially air pollution—is proving deadly to tens of thousands of citizens. Human exposure to hazardous air pollutants (HAPs) can result in both acute and chronic health effects. Short-term, acute effects can include eye irritation, nausea, difficulty breathing, asthma, or even death. Long-term, chronic effects include damage to the respiratory or nervous systems, birth defects and damage to reproductive systems, neurological disorders, and cancer. Aggravated by the exhaust from over 200 million motor vehicles (particularly in larger metropolitan areas), industrial air pollution kills over 60,000 Americans each year. Half a million people living in the most polluted areas in 151 cities across the country face a risk of death that is 15–17% higher than that for those living in the least polluted areas (*28*).

In Massachusetts, poor air quality poses a serious threat to public health. According to data provided by the U.S. EPA Cumulative Exposure Project (CEP), every county in Massachusetts has levels of key airborne toxic chemicals in the form of volatile organic compounds that exceed health-based state levels. At least 16 toxic compounds exceed the acceptable levels of concentration set by both federal regulatory agencies and the Allowable Ambient Limits, a health-based risk standard of the DEP (*29,30*). For instance, concentrations of benzene, 1,3-butadiene, formaldehyde, and acrolein—chemicals that are known to cause numerous adverse health effects, including neurological disorders, birth defects, reproductive disorders, and respiratory diseases—exceed Massachusetts allowable ambient limits in all counties by up to 80 times. Nearly 1,300 deaths are caused by particulate air pollution in Massachusetts statistical metropolitan areas each year (*31*).

In recent years, a number of studies have been conducted on the unequal exposure to air pollution and other environmental hazards. The findings of these studies point to a consistent pattern of environmental racism and class-based ecological injustices (*32*). Within America's urban areas, for instance, lower-income people (particularly those living below the poverty level) are found to be more exposed to combined concentrations of air pollutants than higher-income populations. Similarly, people of color are consistently exposed to significantly more air pollution nationwide than are Whites, with a gap that is wider and more consistent than that for income bias (*33,34*). According to the U.S. EPA, 57% of all Whites nationwide live in areas with poor air quality, compared to 80% of all Latinos (*35*). In Los Angeles, 71% of the city's African Americans and 50% of the Latinos are estimated to live in what are categorized as the most polluted areas, compared to only 34% of Whites (*36*). Unequal exposure to air pollutants for lower-income families and people of color is further aggravated by substandard housing, inadequate healthcare, a lack of public parks and safe spaces, and a lack of social services.

In a previous study, Maxwell (*37,38*) explored whether polluting industrial land uses were differentially distributed regarding the racial (percentage of minority population) and class (median family income and percentage living in poverty) compositions of 351 cities and towns in Massachusetts. Maxwell also examined whether higher intensities of polluting land uses were associated with increased incidence of certain cancers. The study used demographic and land use data from three time points spanning the 35-year period from 1950 to 1985, as well as historical data on industry. The study sought to answer two questions: *a*) Are there inequities in the social distribution of polluting land uses across Massachusetts communities? *b*) Are higher intensities of polluting land uses associated with increased cancer in Massachusetts communities? This study found that traditional manufacturing industries (associated with the "old" economy) inequitably burdened lower-income, higher-poverty, and higher-minority communities. The results of the regression analyses of land use and cancer also suggested that higher intensities of total manufacturing and industrial/commercial land uses were associated with a higher incidence of lung cancer (and probably also bladder cancer and non-Hodgkin's lymphoma) (*39*).

A 1993 study of Essex, Hampden, Middlesex, Norfolk, Suffolk, and Worcester counties in Massachusetts between 1987 and 1992 with data collected by the U.S. EPA under the federal Resource Conservation and Recovery Act (RCRA) (*40*) found that the vast majority of people of color are concentrated in the counties where 82.7% of the state's large quantity generators (LQG) of toxic materials and all commercial hazardous waste treatment, storage, and disposal (TSD) facilities are located. However, a closer analysis of Suffolk County found that 13.2% of LQG/TSD facilities were located in the mostly minority communities (census block groups) and that 26.4% of the facilities were located in the mostly White communities. Thus, it did not appear that in Suffolk County LQG and TSD facilities were concentrated in minority communities. Likewise, the study also found that 34% of these facilities were located in the poorest communities (measured by quartiling block groups)—with a median income of $21,615 or less—whereas 22.6% of facilities were found in the wealthiest communities with a median income of $37,452 or more.

Here we summarize information from the state's Large Quantity Toxics Users who reported to the Massachusetts Toxics Use Reduction Act (TURA) program from 1990 to 1998 (1998 is the most recent year that TURA data are available) (*41*). TURA began in 1989 with the goal of reducing toxic waste generation by 50% by 1997. The program includes a database of toxic waste use similar to that of the federal TRI but with more detailed information. As required under TURA, a company must report the quantity and types of toxic chemicals it uses if it annually manufactures, processes, or uses 10,000 pounds of toxic chemicals or more. These toxic chemicals pose a threat to nearby residents, workers, and the environment from potential accidents, emissions on-site into the immediate environment, worker handling, waste disposal, toxins in the product, and product disposal.

Between 1990 and 1998, 1,029 distinct TURA facilities—ranging from a high of 727 firms in 1991 to a low of 520 in 1998—used over 9.886 billion pounds of toxic chemicals in production (values do not include quantities for chemicals considered trade secrets). During this same time, these large industrial facilities produced 370,163,204 pounds of chemical waste byproduct that they reported as transferred off-site for recycling, recovery, treatment, and/or disposal. Another 164,385,598 pounds of toxic chemical waste byproduct they released on-site directly into the environment (discharged into the air, ground, underground areas, or adjacent bodies of water) of the communities in which they were located—an amount equivalent to 2,055 tractor-trailer trucks each loaded with 80,000 pounds of toxic waste (*42,43*). The electric, gas, and sanitary services sector is the largest source of on-site releases to the environment under TURA. In 1998, the 28 firms in this sector accounted for 39% of all on-site releases, 71% of which were hydrochloric acid. The chemical and allied products sector, which represents a little over half of total statewide use, accounted for 13% of total on-site releases and 31% of off-site transfers.

As shown in Table 10, communities with a median household income of less than $30,000 or between $30,000 to $39,999 compose 50.8% of all communities in Massachusetts but are home to 66.2% of all TURA facilities and 85.6% of all chemicals used by TURA facilities between 1990 and 1998. More important, communities with these median household incomes received 78.7% of all chemical emissions into the local environment by TURA facilities during this time. Although communities with median household incomes of $40,000 or more represent nearly half of all communities in the state (49.2%), they house only 33.8%

of all TURA facilities, 21.3% of all chemical emissions, and 14.4% of all chemicals used by TURA facilities from 1990 to 1998.

In fact, as shown in Table 11, communities with a median household income of less than $30,000 average 6.3 TURA facilities per town, 932,910 total pounds of chemical emissions released into the environment per town, and 73,061 total pounds of chemical emissions per square mile of town space for 1990–1998. This contrasts sharply with communities with median household incomes of 40,000–$49,999, which average 1.8 TURA facilities per town, 161,028 total pounds of chemical emissions per town, and 10,937 pounds of chemical emissions per square mile of town space. In comparison with upper-income communities (median household income $40,000 or more), low-income communities average over three times as many TURA industrial facilities, three times as many TURA industrial facilities per square mile, 3.75–5.79 times as many pounds of chemical emissions into the environment per town, and roughly seven times as many pounds of chemical emissions per square mile. Thus, the data indicate that the class status of a community is a significant predictor of the level of exposure to TURA industrial facilities and emissions. The data indicate that lower-income communities bear a greatly disproportionate burden of the pollution emitted by these types of industrial facilities.

The data also show that communities of color are overburdened. Although communities where people of color compose less than 15% of the population account for 86.2% of all chemical emissions and 84.1% of all TURA facilities, they also account for 94.6% of all communities in the state. Although communities where people of color compose 15% or more of the population receive only 13.8% of all TURA emissions and house 15.9% of all TURA facilities, they compose only 5.4% of towns in the state (Table 12). Table 13 shows that communities where people of color compose 25% or more of the population average 8.8 TURA facilities and 1.1 TURA facilities per square mile, compared to an average of just 2 facilities and 0.12 facilities per square mile for communities where people of color compose less than 5% of the population. In short, high-minority communities average over 4 times as many TURA industrial facilities and over 9 times as many TURA industrial facilities per square mile as do low-minority communities in Massachusetts. Furthermore, higher-minority communities (where 15% or more of the population are people of color) average 1,061,041–1,216,360 total pounds of chemical emissions from TURA industrial facilities and 110,718–123,770 pounds of chemical emissions from TURA facilities per square mile for 1990–1998, compared to just 342,579 pounds of total chemical emissions

Table 10. Class-based disparities in the location and emission levels of TURA industrial facilities (1990–1998).

Median household income (1990 U.S. Census category)	Number of towns (% of all towns)	TURA total chemical emissions (lb)			TURA total chemical transfers (lb)			TURA total chemical use (lb)			Number of distinct TURA facilities		
		Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean
$0 to $29,999 (low)	50 (13.6)	46,645,477	(28.4)	932,910	101,318,279	(27.4)	2,026,366	4,476,070,293	(45.3)	89,521,406	317	(30.8)	6.3
$30,000 to $39,999 (med–low)	137 (37.2)	82,734,924	(50.3)	603,905	188,923,288	(51.0)	1,379,002	3,981,354,062	(40.3)	29,060,979	364	(35.4)	2.7
$40,000 to $49,999 (med–high)	114 (31.0)	18,357,199	(11.2)	161,028	53,110,764	(14.3)	465,884	734,856,631	(7.4)	6,446,111	201	(19.5)	1.8
$50,000 or more (high)	67 (18.2)	16,647,998	(10.1)	248,478	26,810,873	(7.2)	400,162	693,992,469	(7.0)	10,358,097	147	(14.3)	2.2
Totals	368 (100)	164,385,598	(100)		370,163,204	(100)		9,886,273,455	(100)		1,029	(100)	

Table 11. Class-based disparities in the exposure rate to TURA industrial facilities (1990–1998).

Median household income (1990 U.S. Census category)	Number of towns (% of all towns)	Average number of TURA facilities per town	Average number of TURA facilities per square mile	Average total TURA chemical emissions (lb) per town	Average total TURA chemical emissions (lb) per square mile
$0 to $29,999 (low)	50 (13.6)	6.3	0.49	932,910	73,061
$30,000 to $39,999 (med–low)	137 (37.2)	2.7	0.21	603,905	55,524
$40,000 to $49,999 (med–high)	114 (31.0)	1.8	0.13	161,028	10,937
$50,000 or more (high)	67 (18.2)	2.2	0.12	248,478	12,502

Table 12. Racially based disparities in the location and emission levels of TURA industrial facilities (1990–1998).

Non-White population (1990 U.S. Census category)	Number of towns (% of all towns)	TURA total chemical emissions (lb)			TURA total chemical transfers (lb)			TURA total chemical use (lb)			Number of distinct TURA facilities		
		Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean	Count	(%)	Mean
Less than 5% (low)	299 (81.3)	102,730,053	(62.5)	343,579	219,844,801	(59.4)	735,267	5,051,993,299	(51.1)	16,896,299	601	(58.4)	2.0
5–14.99% (low–moderate)	49 (13.3)	39,036,778	(23.7)	796,669	114,887,155	(31.0)	2,344,636	1,885,264,731	(19.1)	38,474,790	264	(25.7)	5.4
15 to 24.99% (moderate–high)	9 (2.4)	10,947,318	(6.7)	1,216,369	14,415,034	(3.9)	1,601,670	182,564,805	(1.8)	20,284,978	67	(6.5)	7.4
25% or more (high)	11 (3.0)	11,671,449	(7.1)	1,061,041	21,016,214	(5.7)	1,910,565	2,766,450,620	(28.0)	251,495,511	97	(9.4)	8.8
Totals	368 (100)	164,385,598	(100)		370,163,204	(100)		9,886,273,455	(100)		1,029	(100)	

Table 13. Racially based disparities in the exposure rate to TURA industrial facilities (1990–1998).

Non-White population (1990 U.S. Census category)	Number of town (% of all towns)	Average number of TURA facilities per town	Average number of TURA facilities per square mile	Average total TURA chemical emissions (lb) per town	Average total TURA chemical emissions (lb) per square mile
Less than 5% (low)	299 (81.3)	2.0	0.12	343,579	22,735
5–14.99% (low–moderate)	49 (13.3)	5.4	0.40	796,689	86,014
15–24.99% (moderate–high)	9 (2.4)	7.4	0.75	1,216,369	123,770
25% or more (high)	11 (3.0)	8.8	1.1	1,061,041	110,718

and 22,735 pounds of chemical emissions per square mile for low-minority communities.

Thus, in comparison with low-minority communities, high-minority communities average roughly 3–3.5 times as many pounds of chemical emissions into the environment from local TURA facilities and 4.86–5.44 times as many pounds of chemical emissions per square mile. Thus, the racial status of a community once again appears to be a major factor in the level of exposure to TURA industrial facilities and pollution. The data indicate that communities of color bear a greatly disproportionate burden of the pollution emitted by these types of facilities (Figure 2).

Unequal Exposure to Power Plants

The electric power industry is one of the most polluting industries in New England and the entire country. In 1998, electric utilities generated 1.1 billion pounds of toxic chemical emissions nationwide, according to U.S. EPA–TRI data. In fact, electric utilities' emissions of sulfuric acid and hydrochloric acid pushed them near the top of the toxic inventory in many states (*44*). Power plants are also major contributors to the formation of smog. Smog, also called ground-level ozone, is formed when nitrogen oxides, emitted as a byproduct of burning fossil fuels at electric power plants and in automobiles, mix with volatile organic compounds in the presence of sunlight. Smog is a major trigger of asthma, increased lung inflammation, coughing, and emergency hospitalization due to respiratory distress. The unhealthiest levels of smog are generally recorded during the summer (*45*). Power plants are also major contributors of gases that cause global warming and toxic mercury emissions that seriously threaten public health and environmental quality.

In Massachusetts, nearly 1,300 residents of statistical metropolitan areas die each year from particulate air pollution (*46*). Air quality continues to deteriorate. During the summer of 1999, Massachusetts recorded 21 unhealthy air days, where the ozone level of those days surpassed the allowable limit set by the U.S. EPA. The people currently most vulnerable to the effects of breathing smoggy air are children, the elderly, and people with asthma or other respiratory diseases (*47*). Despite ongoing attempts to control smog and soot-forming pollutants, the risk of developing cancer or reproductive, developmental, or neurological disorders due to chemical exposures in the air necessitates further efforts in controlling air pollutants.

Coal and oil-burning power plants, specifically those plants built prior to 1977, are a major source of air pollution in the state. In fact, utilities in Massachusetts are responsible for over 60% of the state's soot-forming sulfur dioxide emissions, 15% of the state's smog-causing nitrogen oxide emissions, and 30% of the state's heat-trapping carbon dioxide emissions. Sulfur dioxide emissions are the main precursor to the creation of soot—tiny particles that penetrate deep into the throat and lungs. Fossil-fuel power plants are also responsible for more than 800 pounds of airborne mercury emissions every year. Mercury causes severe damage the neurological system and has developmental effects on fetuses and small children (*48*). Mercury is so toxic that a mere one third of a teaspoon is enough to render the fish of a 25-acre lake unsuitable for children and pregnant women to eat. As a result of a loophole in clean air laws, 14 plants in New England are legally polluting at much higher levels than newer plants built since 1977. The oldest fossil-fuel power plants—those built before 1977—are not required to meet the same emissions standards as newer, cleaner plants (*49*).

As indicated in Table 14, the state's power plants are disproportionately located in communities of color and lower-income communities. Although just 5.4% of all communities in the state are communities where people of color compose 15% or more of the population, they are home to 18.2% of all active power plants and 23.4% of all proposed power plants in the state. Likewise, although 50.8% of all towns in the state are communities where median household income is less than $40,000, they are home to 65.6% of all active power plants and 63% of all proposed power plants.

Five of the dirtiest power plants in the state—the Canal, Brayton Point, Salem Harbor, Mount Tom, and Mystic plants—are legally emitting at 2.9–4.0 times the emission rate of plants built after 1977. The five plants are responsible for 89% of sulfur dioxide emissions and 57% of nitrous oxide emissions from all stationary sources in Massachusetts (the Brayton Point plant is the largest, most polluting power plant in all of New England). In fact, these five plants are responsible for more than 50% of the power plant pollution in all of New England, producing more than 24 million tons of heat-trapping carbon dioxide emissions in 1998. And pollution rates from these power plants have been increasing substantially since 1996 (*50,51*). As a result, these five power plants are the largest industrial sources of greenhouse gasses in the state (*52*).

As shown in Table 15, four of the five plants are located in low-income or moderately low-income communities. Clearly, lower-income communities are disproportionately burdened by the most polluting power plants. In terms of racial bias, only the Mount Tom power plant is located in a high-minority

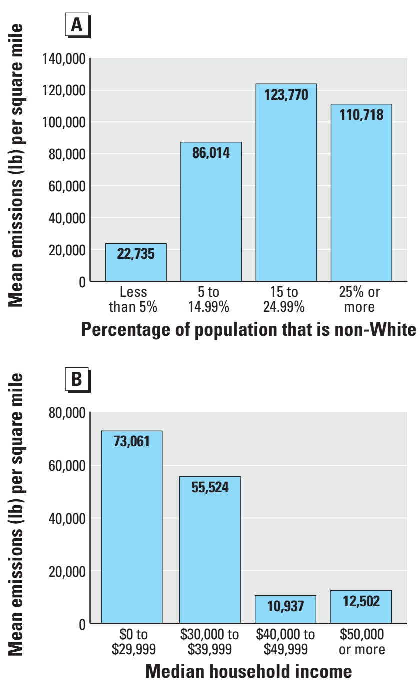

Figure 2. Unequal exposure to industrial pollution, compared with an average of 36,262 pounds of chemical emissions per square mile during 1990–1998 for all 368 Massachusetts communities. (*A*) Exposure to chemical emissions by race. (*B*) Exposure to chemical emissions by class.

Table 14. Racial and class-based disparities in the location of power plants.

1990 U.S. Census category	Number of towns (% of all towns)	Number of DEP active power plants (June 2000) Count (%)	Number of DEP proposed power plants (June 2000) Count (%)
Non-White population			
Less than 5% (low)	299 (81.3)	38 (69.1)	10 (58.8)
5–14.99% (low–moderate)	49 (13.3)	7 (12.7)	3 (17.6)
15–24.99% (moderate–high)	9 (2.4)	7 (12.7)	3 (17.6)
25% or more (high)	11 (3.0)	3 (5.5)	1 (5.9)
Totals	368 (100)	55 (100)	17 (100)
Median household income			
$0 to $29,999 (low)	50 (13.6)	14 (25.5)	2 (11.8)
$30,000 to $39,999 (medium–low)	137 (37.2)	22 (40.0)	7 (41.2)
$40,000 to $49,999 (medium–high)	114 (31.0)	16 (29.1)	7 (41.2)
$50,000 and greater (high)	67 (18.2)	3 (5.5)	1 (5.9)
Totals	368 (100)	55 (100)	17 (100)

community (Holyoke); the remaining four power plants are located in low-minority or moderately low-minority communities.

According to a 2000 report by the Harvard School of Public Health (*53*), current emissions from the 805 megawatt Salem Harbor (Salem) and 1,611 megawatt Brayton Point (Somerset) coal-fired power plants alone can be linked to 43,300 asthma attacks and nearly 300,000 daily incidents of upper respiratory symptoms per year among the 32 million people residing in New England, eastern New York, and New Jersey. An additional 159 premature deaths can be attributed to this pollution each year. However, the health risks are greatest for those living in communities adjacent to these plants. Twenty percent of the total health impact occurs in the 8% of the population that lives within 30 miles of the facilities. The four worst of these polluting power plants are all located in communities where the median household income is less than $40,000. Thus, working-class communities once again appear to be unequally exposed to environmental hazards in Massachusetts.

Unequal Exposure to Incinerators

Municipal solid waste combustors are facilities that combust solid waste derived in large part from household wastes. In 1999–2000, Massachusetts had nine municipal solid waste combustors in operation, which burned approximately 3.3 million tons of trash each year. These incinerators contribute to massive water and air pollution and related public health problems. For instance, garbage incinerators emit more mercury than any other source in the state (*54*). Mercury, which is especially toxic to children and pregnant women, has been linked to kidney and nervous system damage and developmental defects. The U.S. EPA has identified these facilities as being a major source of mercury emissions to the environment, and DEP estimates that these facilities emit approximately 6,040 pounds of mercury into the air each year. DEP testing of in-stack concentrations for mercury emissions from these facilities in 1994 detected averages twice the new U.S. EPA limits (*55*). In addition to air emissions, mercury may also exit these facilities in the form of ash, especially fly ash. As much as another 6,000 pounds of mercury is captured by the air pollution control devices installed at these facilities.

As shown in Table 16, six of these nine incinerators are located in communities where median household income is less than $40,000. Only one of the nine incinerators is located in a community where the average median household income is $50,000 or more. Lower-income communities (less than $40,000) have twice the number of incinerators as do higher-income communities ($40,000 or more). Although class considerations seem to be of some importance in the siting of these facilities, only one of the nine incinerators is located in a community where people of color compose 15% or more of the population. In fact, this is one of the few types of environmentally hazardous facilities in Massachusetts for which there does not appear to be a racial bias.

Table 15. Unequal exposure to the top five power plant (fossil fuel) polluters in Massachusetts.

Power plant	Town	Income status of town	Racial status of town	SO_2 rate in Jan–June 1999 (lb/mmBTU)
Salem Harbor	Salem	Medium–low	Moderately low minority	1.20
Mount Tom	Holyoke	Low	High minority	1.20
Brayton Point	Somerset	Medium–low	Low minority	1.10
Mystic	Charlestown	Medium–low	Moderately low minority	1.03
Canal	Sandwich	Medium–high	Low minority	0.87

Table 16. Unequal exposure to municipal solid waste combustors (MSWCs).

Town	Income status of town	Racial status of town	Mercury in-stack U.S. EPA limit 80 (µg) (dscm)	Average annual amount of mercury emitted (tons/year)
N. Andover	High	Low minority	297.0	1.11
Lawrence	Low	High minority	276.0	0.41
Millbury	Medium low	Low minority	183.0	0.52
Haverhill	Medium low	Moderate–low minority	163.0	0.35
Agawam	Medium low	Low-minority	153.1	0.08
Pittsfield	Low	Low minority	61.4	0.01
Rochester	Medium high	Low minority	61.0	0.11
Fall River	Low income	Low minority	25.6	N/A
Saugus	Medium high	Low minority	17.0	0.4
Total	6 of 9 towns are lower income	1 of 9 towns is higher minority	160.0	3.02 (6,040 lb)

dscm, dry standard cubic meter. Some 117 medical waste incinerators are also listed in the DEP Division of Air Quality Control Stationary Source Enforcement Inventory System (*56*).

Table 17. Unequal exposure to all types of hazardous facilities/sites combined.

1990 U.S. Census category	Number of towns (% of all towns)	Average number of points per square mile
Non-White population		
Less than 5% (low)	299 (81.3)	6.4
5–14.99% (low–moderate)	49 (13.3)	18.7
15–24.99% (moderate–high)	9 (2.4)	42.7
25% or more (high)	11 (3.0)	57.0
Totals	368 (100)	
Median household income		
$0 to $29,999 (low)	50 (13.6)	27.9
$30,000 to $39,999 (medium–low)	137 (37.2)	8.9
$40,000 to $49,999 (medium–high)	114 (31.0)	7.0
$50,000 or more (high)	67 (18.2)	6.9
Totals	368 (100)	

Unequal Community Exposure to Cumulative Environmental Hazards

Many past studies on the disproportionate exposure of low-income communities and communities of color have focused on single indicators of environmental hazards. This study provides a composite measure to assess community exposure rates that includes all hazardous facilities and sites. We have developed a point system that weighs the average risks of each type of hazardous facility/site to arrive at a cumulative measure of community exposure to all potential hazards, shown in Table 17.

We recognize the potential threats to the validity of such a point system. One threat lies in variations in the severity of similar hazard types. For example, we assigned each Superfund site 25 points, yet the risks posed by these sites are likely to vary depending on types of materials they contain, environmental medium through which exposure occurs, size and proximity of nearby populations, and so forth. Second, the relative weights we assigned to different types of hazards may be problematic. For example, one Superfund site may not be equivalent to 25 DEP sites. To assess how well our point system represents current opionion in the field, we distributed the point system to a number of authorities including scholars and professionals at the Massachusetts DEP, who responded that the point system seemed valid to them.

To determine the cumulative exposure to environmentally hazardous facilities and sites, we totaled the points for each hazardous facility and site in each community. Because geographically larger communities could have more facilities and sites, we controlled for the geographic size of each community by calculating the average number of hazard points per square mile, a more valid measure of exposure rate. We found gross imbalances in average point totals for lower-income communities and communities of color based on points per square mile. As shown in Table 17, communities where people of color compose less than 5% of the population average only 6.4 points per square mile, compared to 57 points per square mile for communities where people of color compose 25% of the population or more. In other words, high-minority communities face a cumulative exposure rate to environmentally hazardous facilities and sites that is nearly nine times greater than that for low-minority communities. In fact, there is a consistently sharp increase in the cumulative exposure rates to these hazardous facilities/sites that directly corresponds to increases in the size of the minority population in all communities. Without question, communities of color appear to be greatly overburdened in comparison with low-minority communities and are unequally exposed to environmental hazards of almost every kind.

Likewise, communities where median household income is less than $30,000 average an exposure rate of 27.9 points per square mile, which dramatically contrasts with the exposure rates for communities where median household income is $30,000 or greater, which ranges from 6.9 to 8.9 points per square mile. As a result, low-income communities face a cumulative exposure rate to environmentally hazardous facilities and sites that is 3.13–4.04 times greater than that for all other communities in the state. As is the case with communities of color, low-income communities are disproportionately exposed to environmental hazards of all kinds. Ecological racism and class-based environmental injustices appear to be widespread in Massachusetts.

Table 1 confirms this claim, showing the communities that have the greatest densities of environmentally hazardous industrial facilities and sites. We have constructed an exposure rate using the method described above (whereby the point totals for all hazards present in the community are added together and then divided by the total area). As shown in Table 1, 14 of the 15 most intensively overburdened towns in Massachusetts have median household incomes of less than $40,000. In fact, 9 of the 15 towns have median household incomes less than $30,000. Likewise, 9 of the 15 most environmentally overburdened towns in the state have populations comprising 15% or more people of color. And 6 of the 15 towns have populations comprising 25% or more people of color. This is significant in light of the fact that only 20 communities in the entire state have populations comprising 15% or more people of color—and nearly half are among the 15 most intensively overburdened communities.

In Table 2, we analyze the 20 communities with the greatest number of environmentally hazardous industrial facilities and sites. Using the same method described for Table 1(except that we do not control for size of the community or density of hazardous facilities/sites), Table 2 reveals that 16 of the 20 most extensively overburdened towns in Massachusetts have median household incomes of less than $40,000. In fact, 11 of the worst 15 towns have median household incomes less than $30,000. In terms of race, we similarly find that 9 of the 15 most extensively overburdened towns in the state are of higher-minority status, where people of color compose 15% or more of the population. Again, this is significant in light of the fact that only 20 communities in the entire state have 15% or more racial minorities. In fact, when we combine Tables 1 and 2 and eliminate overlapping towns, we find that 13 of the 25 most environmentally overburdened towns in the state are communities of color (where people of color compose 15% or more of population). As a result, two of every three communities of color in the state are among the 25 most environmentally overburdened towns. In fact, citizens residing in a community of color in Massachusetts are 19 times more likely to live in one of these 25 most overburdened communities.

The conclusion to be drawn from this preliminary analysis is that the communities most heavily burdened with environmentally hazardous industrial facilities and sites are overwhelmingly low-income towns and/or communities of color. Clearly, not all Massachusetts residents are polluted equally —working class and people of color populations are disproportionately impacted (Figure 3).

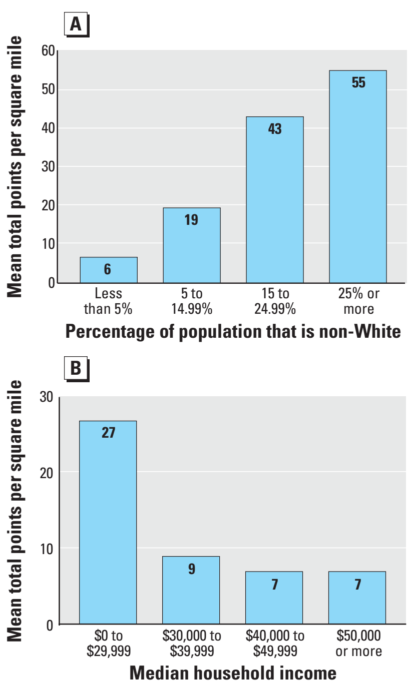

Figure 3. Unequal exposure to all hazardous facilities and sites combined, compared with an average of 10.4 points per square mile cumulative exposure rate for all 368 Massachusetts communities. (*A*) Exposure to cumulative hazards by race. (*B*) Exposure to cumulative hazards by class.

What Can Be Done? Addressing Problems of Environmental Injustice in Massachusetts

Massachusetts should be accountable to all of its residents and strive for equal protection from pollution and other environmental threats. When any citizen is unwillingly harmed by exposure to industrial toxic pollutants found in the environment, an injustice is being perpetrated. So that no citizen of any community be put at risk, government agencies on all levels must deepen efforts to reduce the overall level of dangerous pollutants currently found in the environment, as well as in our schools, homes, and workplaces. In this regard, TURA is a model program that should be expanded. Likewise, DEP should take additional steps to reduce the overall waste stream, increase recycling, and continue a moratorium on new landfills and incinerators. Similarly, capping the cumulative emissions of power plants will reduce emissions in Massachusetts by tens of thousands of tons. It would also ensure that newer, cleaner plants benefit from a level playing field by removing the pollution subsidy old plants currently enjoy. Major cleanups of these plants can take place without major implications for jobs or energy reliability.

In addition to working for an overall reduction in the amount of pollution, Massachusetts needs to undertake a series of special initiatives to address the environmental injustices that exist in the state. As suggested by the evidence presented in this report, all people are not polluted equally in Massachusetts. Ecologically hazardous industrial facilities and waste sites are instead disproportionately located in communities of color and lower-income communities. As a result, citizens do not share the same access to a healthy environment. Massachusetts needs to develop and implement a plan to reduce these disparities for ecologically overburdened communities, beginning with public hearings on environmental injustices so that those who are affected can voice their concerns. As part of these efforts, the state must also begin to more systematically address the environmental injustices documented in this report. This includes the establishment of local, state, and federal government programs and policies that ensure environmental equity; avoid the siting of future hazardous facilities/sites in already overburdened lower-income communities and communities of color; provide resources to these overburdened communities to create environmental amenities that can partly offset other environmental risks; and promote greater citizen participation in the problem-solving and decision-making processes that affect those communities. Elected officials, policymakers, government agency staff, community activists, and ordinary citizens must work together to overcome the environmental injustices that exist in Massachusetts. Furthermore, it is important that any strategies simultaneously address environmental injustices in both the racial and class contexts. Otherwise, efforts to redress one type of inequity over others could serve to foster continued inequity in other groups.

Additional recommendations that the state could adopt for ensuring environmental justice in Massachusetts include the following:

a) Massachusetts should pass an environmental justice law that will ensure equal protection and additional resources for overburdened areas. Such a new environmental justice law, currently under consideration by the Massachusetts legislature, should do the following:

- Make environmental protection a civil right protected under law.
- Create regulations for Areas of Critical Environmental Justice Concern (ACEJC) that would qualify areas overburdened by pollution, hazardous facilities, and sites and/or suffering from poor health for higher scrutiny in environmental permitting and greater levels of resources for cleanup and remediation. Such an act could amend the duties and responsibilities of the Executive Office of Environmental Affairs (chapter 21A, section 2) and call for the development of statewide policies regarding the protection and use of areas of critical environmental concern to Massachusetts.
- Establish toxic-free buffer zones around sensitive receptors such as schools and daycare and healthcare facilities.

b) Massachusetts should increase the level of resources for the DEP and the Executive Office of Environmental Affairs (EOEA). The capacity of the DEP and EOEA to successfully address issues of environmental injustice would require the provision of additional funding, staff, and other resources to adequate levels. Additional responsibilities should not placed on already overburdened state agencies without the necessary funding to successfully perform the work.

c) DEP should also maintain its moratorium on new landfills and incinerators. Incinerators and many landfills pose unacceptable health risks to local residents and nearby communities and should be eliminated. The state should furthermore incorporate environmental justice into all existing regulations, which need to be enforced everywhere, especially in lower-income communities and communities of color. In particular, the following policies and regulations need to integrate an environmental justice orientation:

- Environmental reviews under the Massachusetts Environmental Policy Act (MEPA) should include explicit consideration of disproportionate impact on low-income communities and communities of color.
- There should be strong oversight and enforcement of regulations for hazardous waste site cleanup (Massachusetts Contingency Plan 21E). More resources should be granted to the DEP to ensure rapid and thorough cleanups, especially in overburdened areas.

d) Massachusetts should review and, when necessary, halt the provision of economic development incentives for projects that will contribute more pollution to already overburdened areas. Development incentives such as tax credits and low-cost loans should not be offered to projects that increase pollution in areas already overburdened with pollution sources. To assist in this process, the state should track and monitor environmental disparities:

- A number of factors, such as housing discrimination, bank lending policies, local planning and zoning practices, licensing and permitting processes, and the geographic distribution of public services, transportation networks, industries, and so forth, play some role in creating environmental injustices. The state should undertake and/or sponsor additional investigations to better understand the sources of environmental injustice.
- DEP does an excellent job of making its databases available to the public. These efforts can be further enhanced by keeping track of its progress on reducing environmental disparities. This information should be accessible to the public over the internet. Additionally, more health and environmental monitoring needs to be implemented in areas of high concerns. The state should ensure that the DEP receives adequate resources to perform these functions.

e) Finally, Massachusetts should adopt the "precautionary principle" over standard risk-assessment procedures when addressing environmental issues in overburdened communities. The precautionary principle says that if there is a strong possibility of harm (instead of a scientifically proven certainty of harm) to human health or the environment from a substance or activity, precautionary measures should be taken. Under current approaches to risk assessment in the state, environmental policy is oriented to promoting the dispersion of pollution to what are considered "safe levels" of public exposure. However, if pollution is instead highly concentrated in certain communities, as we have shown, then this approach is inadequate. Overburdened communities must be granted additional protections as offered by the precautionary principle, which includes promoting additional study of activities of concern, shifting the burden of proof so that a chemical/activity is proven safe, and providing incentives for preventive behavior, and/or measures such as bans or phase-outs of substances suspected of causing harm. The time has come for the legislature and state officials to work hand in hand with the environmental justice movement and community representatives to end environmental racism and promote new models of clean production and sustainable economic development.

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